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FACSIMILE TRANSMISSION IN LIBRARIES-A STATE OF THE ART SURVEY.

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FIVE SYSTEMS, ALL OF WHICH HAVE INVESTIGATED OR ARE INVESTIGATING THE USES OF FACSIMILE EQUIPMENT AS APPLIED TO LIBRARIES, ARE SURVEYED. THE EQUIPMENT OF EACH PROJECT, INCLUDING NECESSARY COMMUNICATION LINKS, IS DESCRIBED, AS WELL AS THE RESULTS OF THOSE EXPERIMENTS NOW COMPLETED. IF TELEFACSIMILE IS TO BE USEFUL A NEED FOR A CHANGE IN SOME INTERLIBRARY LOAN PROCEDURES IS INDICATED. OTHER CONCLUSIONS OF THE STUDY ARE--(1) THAT FACSIMILE TRANSMISSION IS TECHNICALLY AND ECONOMICALLY FEASIBLE NOW FOR MANY LIBRARY SYSTEMS, EVEN THOUGH BOUND VOLUMES STILL CANNOT BE HANDLED BY PRESENT EQUIPMENT, AND (2) THAT CURRENT DEVELOPMENTS AND PLANNING BY MANUFACTURERS WILL MAKE FACSIMILE TRANSMISSION EVEN MORE SATISFACTORY IN THE FUTURE. AN EXTENSIVE BIBLIOGRAPHY OF 56 ITEMS ABOUT FACSIMILE TRANSMISSION IS GIVEN. (CM)

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FACSIMILE TRANSMISSION IN LIBRARIES:

A STATE OF THE ART SURVEY

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INTRODUCTION

Facsimile transmission is the rapid transmission of printed pages from one point to another using electronic devices. Its actual use by libraries has been rare and primarily on an experimental basis. Major use of such systems has been confined to such areas as newspapers, wire services and companies which can afford the high cost of such services. The technique has now reached a point of development, technical competence and lower cost to warrant a thorough investigation of the feasibility of its use in a library environment.

All facsimile transmission methods require converting the original picture to an electrical impulse, which is then transmitted over telephone lines, private lines, microwave or some combination of these communication links. The receiving unit reconverts the electrical impulse into an exact duplicate of the original document on a screen or in the form of a hard copy.

BASIC FACSIMILE CHARACTERISTICS[1]

1. Facsimile is available that can accept and transmit any type of information which exists on paper, and will do so without any intermediate transcribing or processing.

2. Facsimile will operate over any available communications medium including telephone lines, overseas cable, radio, microwave and COMSAT satellite.

3. There is no technical limitation to the distance over which facsimile can be transmitted.

4. Most facsimile systems are designed to accept and transmit standard 8-1/2" x 11" pages. However, production equipment is available which will handle engineering drawings or other copy up to 18-3/8" in width and unlimited in length. Facsimile recorders are available up to 36" in width.

5. Most facsimile recorders utilize special electrosensitive or pressure sensitive paper not unlike special papers used in many copying machines. Presently available papers are suitable for most applications; however, photographic means are used where extra-fine resolution and/or subtle tone shading are required. Some models mark chemically on regular papers.

6. For copy of average nature, such as a printed page, the time to transmit a page over telephone lines varies between 3 and 6 minutes. Production equipment is available which will cut down the transmission time by factors of as much as 20 times, but this requires substantially more expensive lines.

7. Where extra-fine copy is involved and/or where very high quality reproductions are desired, facsimile equipment with resolution up to 1,000 lines per inch is available.

8. Facsimile can transmit from colored originals, but the received copy is all of one color (although tone shades may be received on many systems). To date practical economic considerations have ruled out color reception, although it is technically feasible.

9. Facsimile scanners are available which operate with microfilm chips or slides; hence can be used to transmit microfilm records and reproduce them in enlarged form at remote locations.

10. Information in facsimile form can be stored on magnetic tape where it can be slowed down, speeded up and otherwise manipulated.

11. Computer generated information can be processed by an available "scan converter" and transmitted over telephone lines in facsimile form.

12. Facsimile signals can be digitized and encrypted for secure communications over telephone lines.

13. Facsimile network switching systems may be as automated and flexible as those for other types of communications networks. Switching techniques employed today are, for the most part, quite simple because few if any large, complex networks have been so far placed in operation.

The cost of communications rather than facsimile equipment may become the major factor in a facsimile network covering any reasonable distance. The most fruitful opportunity for reducing the cost per page is to design equipment which can operate over less costly types of lines. Speed of document transmission, copy resolution and overall system cost are interrelated. If one wishes to increase speed, e.g. from 12 pages per hour to 24 pages per hour, he may do so by cutting the resolution in half (producing a coarser receiver copy) or by using a transmission line of greater bandwith and consequently increased cost. Because of these

interrelationships, a facsimile communication system should be carefully tailored to the intended application. Many cases have occurred where facsimile has been pronounced a failure simply because it was being used to transmit copy requiring finer resolution than the particular equipment and transmission lines were designed to handle. It is easily possible to pay a prohibitive premium in system cost by specifying higher speed equipment and more lines than may be required.

ACTUAL SYSTEMS

University of Nevada Library[2]

In June 1965 a Council on Library Resources Grant was awarded to the University of Nevada to conduct a 30-day test of the Xerox Magnavox Telecopier, a relatively simple, low-cost telefacsimile system which uses ordinary telephone handsets as the connecting link between machines. The study was conducted between the Reno and Las Vegas campuses of the University of Nevada and the Davis Campus of the University of California. The equipment consisted of a transceiving unit and a telephone coupler at each station. The transceivers are portable desk-top units comparable in size to an electric typewriter. There is no installation procedure necessary other than plugging a cord into a regular 110-volt A.C. outlet. The communication link is effected by first establishing voice contact via a telephone call from one station to another; when one operator has copy ready to transmit and the other is ready to receive, both operators place their telephone handsets into the phone

couplers. The transmission link is then established and the transcriving automatically begins. Copies of printed pages, typescript, manuscript, or illustrative material may be transmitted any distance over a single voice-grade telephone line, to any location where there is a telephone and a corresponding telecopier unit.

This equipment will accommodate single sheets only, and will not copy directly from books. A full 8-1/2" x 11" page may be transmitted in less than 6 minutes. Scanning proceeds at the rate of 180 lines per minute, at 96 lines per inch, so that a page with 5 vertical inches of transcript may be transmitted in less than 3 minutes. Copies are received on ordinary paper, the facsimile being produced by pressure of a stylus through carbon paper.

Results of the Nevada experiment indicate that the system is feasible and convenient for routine interlibrary use provided that improved reliability and consistency of copy quality is attained in later production models. Transceiving time for an average 10 page request is about one hour. An average total elapsed time of 4 hours for compilation of requests can be achieved. At 1,000 pages per month operating cost is $4.60 per 10 page transmission, including all staff time and a $3 telephone line charge average about $9.85. Copy quality appeared to be adequate for most library material when the equipment was performing properly. Reliability of the equipment was poor, with inconsistent quality and frequent breakdowns. However, since the machines used in

this test were very early production models, it seems reasonable to expect considerable improvement in this respect as experience is gained in the manufacture and servicing of the Xerox Magnavox Telecopier.

University of California[3]

In June 1966 H. G. Morehouse and R. M. Shoffner of the Institute of Library Research prepared an interim report for the CLR entitled An Experiment in Library Application of Xerox LDX Facsimile Transmission Equipment. The report was an effort to describe in broad terms the framework and scale of library operations appropriate to the LDX system.

In terms of typical library equipment, the LDX (Long-Distance Xerox) is a relatively sophisticated, costly system with a Scanner (transmitter), Transmission Link and a Printer (receiver). The Scanner and Printer are comparable in size to the Xerox 914. The Scanner operates by sweeping a narrow light beam back and forth across the page to be copied. The reflection of this beam is focused into an electronic system where the variations in light reflected by the image on the page are converted into electrical impulses. These impulses are transmitted via either cable or microwave signals to the Printer, where they are converted back into light by a cathode ray tube. This tube projects the light impulses onto a drum, from which a finished copy is produced by the conventional Xerox process. The Scanner will accommodate single pages only, and is not capable of copying directly from bound or unbound volumes. Pages may range in size from a minimum of 3-1/4" to a maximum of 9-1/2"

wide by any length. Original copies, Xerox copies or photocopies of printed pages, typescript, manuscript, line drawings, maps, etc. of any color may be transmitted. Copies produced by the Printer are positive (black on white), not effective in reproduction of half-tones, and are comparable in appearance to the copies produced by the Xerox 914.

Single sheets to be transmitted are manually fed into the LDX Scanner's document conveyor one at a time. Copies are produced by the Printer on a continuous strip of paper, which is automatically cut to size. No operator is necessary for the printer after its initial daily warm-up cycle. Speed is the essential capability which makes this equipment potentially valuable for library use, in spite of its apparent costliness. The volume of traffic in interlibrary transfer of information is constantly increasing and procedures now in general use tend to be slow and cumbersome. The average elapsed time for an interlibrary loan transaction between University of California campuses is now 6-7 working days. This time could be reduced to less than 3 hours for most periodical articles, technical reports, and government publications (the types of material which are now usually copied by Xerox and mailed). Such rapid interlibrary service is unprecedented, and would make possible entirely new concepts of cooperative sharing and distribution of library resources.

The report introduced some major deviations from present interlibrary loan practices so that maximum benefits could be gained from the rapid transmission capability of the LDX system:

1. The requester is not required to submit his request to his campus interlibrary loan office where time consuming procedures are normally required, such as formal verification or citation of reference source, but may telephone his request directly to the LDX office at the source library. If the information he supplies is not sufficiently complete or accurate to enable the source library to identify the item desired, or if the item is not available, the requester is notified directly by telephone.

2. After the transmission is completed, the material will be delivered to the requester, thereby eliminating delay time caused where material is held for pick-up by requester and substituting messenger's time for requester's time.

3. The ALA forms for interlibrary loans and requests for photocopy would not be used. The represented codes place time consuming burdens on the borrowing library, the philosophy being that the lending library is performing a service for someone outside its normal clientele, and that it should be burdened with as little work as possible. Thus, requests should be carefully verified before submission. With an LDX service, with its obvious prerequisite of closely cooperating libraries, a simple work sheet should be sufficient as an instruction for and a record of each transaction. Work measurement studies could then provide the basis for budgetary transfers to cover the work of the source library.

Conclusions of the California study:

1. The LDX system appears to be capable of providing rapid, high-quality transmission of printed pages from one library to another, with elapsed time for each transaction averaging 2-1/2 hours instead of the week or more now typically required.

2. The cost of an LDX system precludes its use in libraries at current interlibrary photoduplication service levels.

3. There is great potential for expanding access to existing large serials collections by establishing an LDX network serving several libraries, each with smaller collections of the more frequently used titles.

Houston Research Institute[4]

In May 1965 the Houston Research Institute, under contract with the National Science Foundation, conducted a study of the feasibility of transmitting technical information by facsimile over existing communications networks, including oil and gas pipeline networks, between Houston and the major centers of technical information in the United States. The study consists of an investigation of existing facsimile systems to determine their applicability to oil and gas pipeline networks. Of the major communication networks evaluated, three offered potential use for a nation-wide exchange of technical information — oil and gas pipeline networks, NASA Mission Control Circuits and Military Amateur Radio Service (MARS). The project was initiated on the assumption that transmittal of

technical information was the major bottleneck in the exchange between Houston and other technical centers. By the time the second or practicability phase was reached it became readily apparent that the actual transmittal was not the major drawback. The big problem, which was evident in most of the other studies, appeared to be the numerous steps which both precede and follow the actual transmittal. Conclusions drawn from Phase I of the study were:

1. Transmission of technical information by facsimile using existing pipeline microwave links between Houston and the major centers in this country is technically feasible.

2. There is unused microwave transmission time during off-shift periods in certain pipeline systems and other major systems.

3. Pipeline officials are receptive to consideration of the use of unused off-shift time.

4. With nominal or no charges for communications links, the cost of facsimile transmission of technical information would be comparable with the present system of photocopy exchange if adequate loads can be achieved. As additional centers are added and the service expands, the cost would decrease.

5. There are no significant legal problems beyond those now of concern in the exchange of library photocopies.

It was concluded that the establishment of a facsimile transmittal system is not justified until major improvements have been made in present library procedures for information storage and retrieval.

Massachusetts Institute of Technology[5]

The Text-Access Program at Project INTREX is an experimental effort to devise a workable system which would provide guaranteed rapid access to full text of journal articles, books, reports, theses, and other library materials at stations which may be close to or remote from the central store. User acceptance and economy are also to be studied. It became apparent early in the study that, in the immediate future, it was not feasible to consider storing in computer memory all the full-text information contained in a full-scale library system. After a critical examination of several possibilities they settled on photographic film as being the most appropriate text storage medium. The high storage density of film and the well-developed methods for transforming paper copy into photographic copy, and vice versa, made this medium attractive until such time as massive computer memories became available at reasonable cost. Once the decision was made to store original text in image form, a facsimile-like system was proposed in which each text page is scanned and transmitted once, and the information is captured and stored at the receiver for transient viewing (soft copy) or printing (hard copy).

This text-access system is conceptually divided into four major parts: a central station; a transmission and distribution subsystem; several user stations; and a central computer.

The Central Station consists of a collection of documents, either in microfilm or microfiche (largely the latter), stored and indexed for

easy access by an automatic mechanism; an access machanism, which selects the requested document, presents it to the scanner, and after use, returns it to storage; one or more scanners, each scanning the requested page of the document it holds and converting the image into a single-frame video signal; and a control unit, which communicates with the central computer and controls and coordinates the operations of the access mechanism, the scanners and the transmission sub-system. The control unit also prefaces each transmission with an address code which directs the image signal to the proper user station.

The Transmission and Distribution Subsystem consists of a transmitter located at the central station which multiplexes the video and control signals and generates an appropriately modulated transmission signal; a transmission medium (telephone pairs) which carries the signal to the various users' stations; and a receiver at each user's station which demodulates the transmission signal and reconstitutes the video and control signal.

A User Station consists primarily of a device which, when addressed by the control unit, will reconstitute and display the image of the requested page in soft-copy form, and provisionally an optional device to reproduce that page on film and/or paper.

The Central Computer serves to control the whole system, and receives requests for accessing text from the users via their keyboards.

This single-frame microfilm facsimile system (4.5-MHz) has now been assembled and partially evaluated. In its present configuration

the system consists of three basic parts — a flying-spot scanner, receiver, and a video transmission channel. The system is now able to transmit microfilm images and to re-create them at the receiving station. The present quality of the re-created image appears to be high and quite adequate for most library requirements. The facsimile system is being used as a test bed to relate picture quality to bandwidth requirements for the various components that comprise the system. Although now operating as a microfilm facsimile system, the equipment is flexibly designed so that other kinds of image re-creation equipments at the receiving end can be substituted as these equipments become available.

New York State Library[6]

The Division of Library Development of the New York State Library is conducting a seven-month pilot program to investigate and study methods of graphic transmission as a means of improving research library services. Demonstration of the feasibility of graphic transmission as an efficient and economic improvement over present methods of document transmission during this study will result in the establishment of a statewide network. The facsimile transmission system pilot project, known as FACTS (FACsimile Transmission System), is expected to be completed by the end of MARCH 1968. The project comprises 14 stations, six of which have both receiving and sending facilities and eight which have only receiving equipment. Those libraries in the network which constitute a major resource have been given sending capabilities. These libraries will answer the requests of the

system. Requests will be transmitted over a previously established TWX network. A printed form is filled in and filed at the State Library which gives a history of the particular transaction and all pertinent statistics to that transaction.

The information flow in the system is as follows: All requests go initially to the State Library in Albany. The State Library will attempt to fill the request. If the request cannot be filled at the State Library then the library most likely to hold the material among the other libraries with sending capabilities are queried. When the material is found, the holding library is connected directly to the requesting library by means of a switching center at the State Library in Albany. There can be no station-to-station communication within the network without first going through the State Library Switching Center.

The 14 installations are: New York State Library, Albany; New York Public Library Reference Department, New York; Cornell University, Ithaca; Buffalo and Erie County Public Library, Buffalo; Monroe County Library System, Rochester; Columbia University, New York; Nassau Library System, Garden City, Long Island; Suffolk Cooperative Library System, Bellport, Long Island; Westchester Library System, Mt. Vernon; Mid-Hudson Libraries, Poughkeepsie; Mid-York Library System, Utica; State University of New York, Albany; State University of New York, Potsdam; and State University of New York, Binghamton.

The pilot project is testing the facsimile transmission equipment of two manufacturers. Eleven of the participating institutions will use

only Stewart-Warner (Datafax) units and two will employ Alden Facsimile Devices; the State Library will utilize both kinds of equipment.

The major objectives of the New York study are:

1. To analyze and evaluate the pilot experience and ascertain the feasibility, from the standpoint of library service rendered, of an on-going facsimile transmission network for the libraries of New York State.

2. To determine the extent to which the number of facsimile sending and/or receiving devices at each participating library was adequate for the transmission volume experienced.

3. To establish whether, in the various regions of the state, the location of the pilot project's receiving units is appropriately related to the process of referral and the varying amounts of facsimile copy received by libraries in the area.

4. To ascertain whether the State Library's grant to participating institutions fully covered their additional clerical and copying machine rental costs during the pilot period.

The Technical Evaluation of the system is being conducted by the Division of Library Development and Office of General Services staff and will be completed by August 1, 1967. The evaluation will cover the competing facsimile equipment, the competing transmission lines and the switching mechanism.

Statistics will be compiled on these aspects of FACTS:

1. Down time. Inoperability of equipment due to mechanical, transmission line, or personnel problems.

2. Ease of Operation. The man-machine interface of all the technical appurtenances of FACTS.

3. Amount of utilization.

4. Resolution. Quality of copy. Study of copying machines being used.

5. Type of requests not transmittable due to mechanical limitations.

6. Transmission speed. (Are significant backlogs being created because of slow transmission speeds or is the present equipment rapid enough?)

7. Switching mechanism. Ease of operation. Staffing required. Automatic or Semi-Automatic? Other switching facilities available.

8. Requests via high speed facsimile equipment as opposed to TWX.

In order to obtain these statistics each of the FACTS stations will be asked to keep a log on machine operations, including a record of all transmissions and difficulties (and their duration) and a file of unacceptable copy. Constant liaison will be maintained between the Central Station representatives and the other FACTS stations.

A System Function Evaluation is being conducted by Charles Nelson Associates, Inc. and will be completed by October 1, 1967. An interim report on the progress of the system will be submitted on June 1,

1967. The future technical configuration of FACTS will be dependent upon the outcome of these evaluations. It is planned that the technical evaluation report will be published concurrently with the Nelson Associates report on the other aspects of FACTS.

Some reactions as to what has occurred during the running of FACTS from Lynn R. Hard, Academic and Research Libraries Consultant, are:

The equipment has been down very little. The greatest problem with resolution is the quality of the original copy. Xerox copies are too light for good transmission over Stewart-Warner equipment. Automatic document loaders are a must. Acoustic silencing hoods seem to be desired. The ability to transmit continuous tone illustrations is a necessity. A very large number of the requests handled are cored around illustrations. Very large libraries do not need extensive receiving capabilities. Very small libraries do. Ninety per cent of the difficulties encountered with FACTS have to do with people receiving requests, retrieving the material, and getting it in to the machine.

As a clause in a final, if any, FACTS contract, the equipment supplier would have to agree to produce, within two years, a machine that would transmit directly from bound materials. It is encouraging to note that both Stewart-Warner and Alden seem to be mak ng progress in this area.

CONCLUSIONS

During the course of research for this survey, several conclusions have become evident:

The facsimile industry, which has remained static at a level of $15-18 million for several years, appears to be on the verge of a substantial expansion. The recent entries of Xerox and Magnavox into the facsimile field is symptomatic of great and accelerating interest displayed by commercially oriented companies in "remote copying" techniques.

Major user companies and potential users are beginning to devote to facsimile the serious systems planning effort that is required to integrate any new technique into a major corporate structure in significant depth.

Developmental programs show promise of resulting in terminal equipment which will process the facsimile signal so that it can be transmitted more efficiently over existing transmission facilities.

Service has been an important problem in commercial facsimile installations. Because such installations have been relatively scattered, it has been difficult to provide adequate field service on an efficient and economical basis. This situation has led to somewhat less than optimum equipment performance in the field; however, substantial improvement can be predicted as the number of installations increase to a level sufficient to justify broader service coverage coupled with resultant improved supervision and training programs.

Although no one manufacturer has equipment currently available to meet all requirements for an acceptable inter-library operated facsimile transmission system, it is evident that through a combination of various

types of equipment and continued advances in technology, facsimile transmission in a large library environment is technically feasible and economically possible for many library systems. The current literature and the consensus of individuals working with such a system indicates the fact that facsimile in libraries is fast becoming a reality. The essential feature that is missing from currently available machines is the ability to scan directly from the pages of a bound book. Fortunately, several manufacturers are making progress in this area and new developments are forthcoming. With improvements in electronic transmission devices increasing at its present rate and the cost of such systems decreasing proportionately, facsimile will, in the forseeable future, become a major technique for controlling and disseminating the ever increasing volume of published information.

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